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1918

UNIVERSITY BULLETIN

NEW SERIES, VOL. XIX, NO. 19 MARCH, 1918

UNIVERSITY OF MICHIGAN
SUMMER SESSION

ANNOUNCEMENT

FOR THE

BIOLOGICAL STATION

EIGHT WEEKS, JULY 1—AUGUST 23

TENTH SEASON, 1918

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The Biological Station of the University of Michigan

A station for instruction and research in biology will be maintained by the University of Michigan, for the tenth season, as a part of its regular Summer Session, during the eight weeks from July 1 to August 23, inclusive, 1918.

LOCATION

The Station is located near the Engineering Camp of the University on a tract of about 3060 acres of land owned by the University and stretching from Douglas Lake to Burt Lake in Cheboygan County, Michigan, 17 miles south of the Straits of Mackinac. This region, diversified by hills and valleys, was formerly covered by forests of hardwoods and conifers. Small tracts of the former still remain. It contains many lakes of clear water, unsurpassed in the state for size, depth, and beauty of setting. The elevation of the camp, between one and two hundred feet above Lake Michigan, insures cool nights.

Six miles to the west of the camp on the Grand Rapids and Indiana Railway is the nearest railroad station, Pellston, a town of some 1,300 inhabitants, with a bank and a variety of retail establishments. Topinabee, on the Michigan Central Railway, is 8 miles from the camp. Fifteen miles to the northeast, also on the Michigan Central Railway, is Cheboygan. A state road connects these points and passes near the laboratory. Except for two small summer resorts on Douglas Lake the region for miles about is almost uninhabited. Douglas Lake is two and one-half miles wide and nearly four miles long. Its shores are everywhere wooded, in some places low and receding, in others rising in terraced bluffs 70 feet in height. The beach is of clean sand and the lake bottom slopes gradually into deep water.

OPPORTUNITIES FOR BIOLOGICAL WORK

The physiography of the region in which the Biological Station is located, the types of vegetation present, and the kinds of botanical work which may be carried on at the Station have been described by Dr. F. C. GATES, in his report to Director GLASER in 1916, as follows:

"Douglas Lake is located in the northern part of the Lower Peninsula of Michigan about 17 miles each from Petoskey, Mackinaw City and Cheboygan on highland 133 feet above Lakes Michigan and Huron. This location in the transition belt between northern coniferous vegetation and central deciduous forest or hardwood vegetation makes this region particularly valuable for the study of conditions thus represented. No other biological station in the United States is favorable for the study of these conditions.

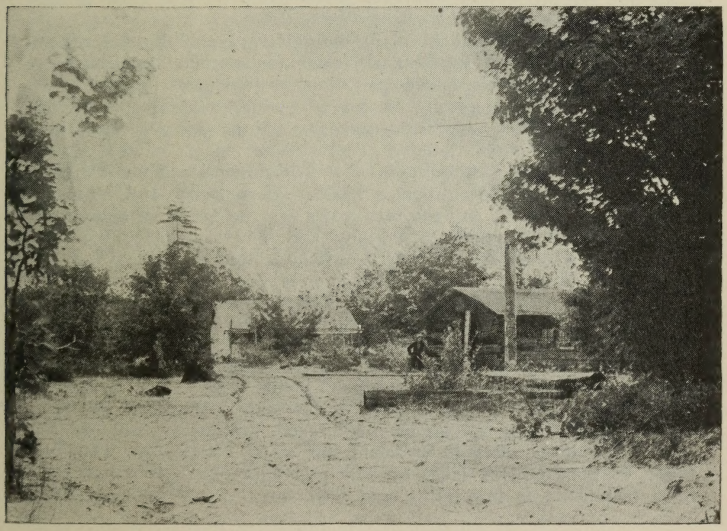
"Glacial deposits were thickly strewn over the entire region, resulting in essentially flat country. Low ridges, occasional hills and small streams and lakes vary the monotony. Of the lakes in the region, Burt Lake is the largest, being about 20 miles in length. Douglas Lake is about 4 miles long and about 2 miles across in the widest part.

"Three conspicuous soil types are well distributed in the region. On the uplands the better class of soils is clayey—the poorer class, sandy. Hardwood or deciduous forests are the normal vegetative cover of the clayey soils and pine forest of the sandy soils. At the present time, following lumbering and devastation by fire, part of the clayey soil and all of the sandy soil is vegetated with aspens. The lowlands of the region are usually bogs and support the bog type of vegetation. Less abundant, but thoroughly characteristic, is the vegetation of the lake shores, river banks and the occasional sand dunes found in the region. Thus it is evident that a wide variety of conditions are present in the region. A diversity of work is therefore possible.

"The beech-maple forest, occupying the better soil on the uplands, is quite similar to that occurring throughout the state of Michigan. The characteristic trees are sugar maple, beech, hemlock, and white ash. Several such forests are within 2 to 5 miles of the station, but the best forests are along the Jackson and Tindle Lumber Railway some 15 and more miles west of the station.

"The sandy uplands are now occupied by aspens in place of the pine normal to such situations and formerly present. No adequate idea of the original conditions can now be gathered from the vicinity. The nearest that one can get to conditions approaching original is back of the dunes along Lake Michigan in the Big Stone Bay region, about 17 miles west of Mackinaw City. Aspen vegetation is quite typical of a good deal of the state holdings. Considerable experience, valuable information and useful practice with regard to such land may be gathered in the Douglas Lake region. The aspens are rather short-lived trees, seldom attaining respectable size. They gain easy access to a region which is burnt over and play their part in making the ground again suitable for the original kinds of trees. Ample testimony of this fact is had on every hand. One has but to note the frequent occurrence of seedlings, naturally occurring, and the ease with which planted seeds develop, to realize that, in the absence of fire which proper protection can reasonably assure, the region will again become pine. Near Douglas Lake this may be accom-

HOUGHTON HALL, ONE OF THE LABORATORIES (SEE P. 10)



THE TENT AND LOG LABORATORIES, AND "TOTEM" POLE

plished in 20 to 40 years. Back from the lake under severer conditions it will take longer unless the region is artificially planted.

"The bog type of vegetation is plentifully represented, both in mature form and in developmental stages, within easy access. The bog trees are mostly coniferous. White cedar (arbor vitae), tamarack, spruces, and balsam are all abundant. The ground flora is quite typical and quite "northern." A study of these northern forms is one of the valuable features of the region. Several orchids are found in such situations, together with the interesting insect-catching sundew and pitcher plants.

"In addition to the three prominent types of vegetation mention may be made of interesting plants along the lake shores: Utricularia, with little bladders catching crustaceans and even small insects, and Decodon, with well-developed air tissue. The river banks furnish their quota of interesting species. The streams, although small, furnish a wide variety of conditions from slow, sluggish creeks to a rapid mountain stream in Carp Creek near Cecil Bay. The lakes vary in size from very small ones with no outlet, through Burt Lake, the largest of the inland lakes, to Lake Michigan and Lake Huron. Neither of the latter are within access of regular station activities. Very small, but still typical dunes are within the region. Dune work, however, may be supplemented by a trip to the dunes along Lake Michigan.

"With such a diversity of conditions, together with the secondary effects introduced by fire, the dynamic activities of the vegetation are great and permit a very adequate presentation of ecological principles."

Among the problems in plant ecology suggested by the region are: "the development of certain habitats, successional relationships, correlation of vegetation and evaporation, physiological limitations of habitats and species, growth increments under varying conditions, changes in soil and vegetation due to cutting, burning, draining, planting, and seeding."

The region likewise offers a rich field for scientific work with the Cryptogams. Algae abound in the lakes, pools and streams; lichens, mosses, ferns, and the fern allies may be found in abundance in habitats varying from Sphagnum and Thuya bogs to the dry, sandy aspen associations. Rusts, smuts and other parasitic fungi infest a vast variety of hosts, offering an abundance of material for the investigator. The study of the Cryptogams is practically a virgin field at the Station, little work having been done in that line. There is, however, a collection of lichens and mosses for comparative study.

For the study of animals the region is probably not quite so well adapted as it is for the study of plants. The fauna is not as rich as it is in the southern parts of the state. Mammals are few. There are not many species of amphibians, reptiles or fish, but the number of individuals is sufficient for good collecting. The fish fauna of the chain of lakes of which Douglas Lake is a part and their tributaries is interesting and well worth study in comparison

with the fauna of the Great Lakes. Birds, though not as numerous as in many other localities, are sufficiently numerous and the range of their habitats within easy reach of the Station is such that good work can be done. Numerous problems dealing with the ecology of birds, their behavior, and the activities of breeding and nesting birds await attention. A fair proportion of the birds which nest there are known to most ornithologists as migrants only.

The invertebrate fauna is relatively much richer than the vertebrate fauna. There are many terrestrial and aquatic molluscs and many crustacea, including the plankton forms. Owing to the prevalence of sandy soil the number of annelid worms is small. Sponges and bryozoans are fairly common, while Hydra appears at times in countless numbers. Insect life abounds in the varied habitats of the region.

Parasitism in animals is extremely common. Parasitic worms are abundant both in species and individuals. All the vertebrates which frequent water serve as hosts for parasites, both adult and immature, while the numerous invertebrates yield young stages of many of the worms. Owing to the moderate size of the lake the collection of hosts is easy. With pens, cages, and aquaria now available the study of life-histories by means of feeding experiments is rendered possible. Practically no study has been made of parasitic worms infesting those vertebrates not frequenting water. The parasitic Protozoa of the region have been but little studied.

The very fact that the fauna, as pointed out, is not as rich as it is in many places simplifies many of the problems of the zoölogist. Here the ecology of aquatic invertebrates may be studied under most excellent conditions. The habitats are almost typical, are readily accessible, and the student is not overwhelmed with the multiplicity and diversity of forms to be found in some localities.

The attractions of a northern flora, an adequate though not complex fauna together with an excellent climate, good conditions for study, freedom from interruptions, freedom from summer visitors, and freedom from the exactions of a university schedule and from the conditions of urban life make the Station a good place for study and research.

PREPARATION FOR TEACHING

The courses in Botany and Zoölogy offer excellent preparation for teaching these subjects in secondary schools and colleges. In Zoölogy and, to a certain extent, in Botany there is a movement away from the old type studies with especial emphasis upon morphology, and a definite trend toward a study of animals and plants as living things bearing certain relations to the places in which they live and forming certain kinds of societies with other living things. It is this latter view of biology which is stressed at the Biological Station, by means of field courses in which actual training in field methods is given.

A Class at Work

A Welcome Diversion After the Day's Work

GENERAL LIVING CONDITIONS

At a station of this character the general conditions of living are necessarily somewhat different than in a city. However, reasonable comfort, and especially health, are carefully provided for.

Board and Lodging.—Tents for the use of the students and staff are pitched near the Station buildings. Each is erected over a permanent frame, and is waterproof, stormproof, and comfortable. Each tent, 14 x 14 ft., accommodates a maximum of four persons and is covered by a fly, provided with a wooden floor, and equipped with mosquito bed-canopies, pail, tub, washstand, pitcher, bowl, table, chairs, lantern, cots and mattresses. Stoves will be supplied if needed. Students will provide their own towels and bedding, and those who prefer to do so may bring their own tents and thus save a tent fee of eight dollars. Such tents must be pitched in accordance with the regulations of the Station and all will be subject to inspection.

Space in tents is allotted in advance upon receipt of the reservation fee of eight dollars, or after registration. The attempt is made to place congenial people together. Students will find the tents ready for occupancy, but they are expected to care for them personally during the session.

Mrs. Max M. Ellis, Dean of Women, has general supervision of the women's quarters, and is ready at any time to advise women students.

Board at the Station is furnished on the coöperative plan, under the direction of committees appointed by the Director. The mess-fund will be administered by a faculty representative. It is planned to furnish board at about $5.25 per week. Members of the Station are not permitted to cook their own meals. In order to make possible the purchase of supplies at low cash prices, each member of the Station must, on arrival, deposit with the faculty member in charge of mess funds forty-two dollars in cash or draft. Students leaving before the close of the session will receive three-fourths rebate of their unexpended portion, and all excess will be returned to others at the close of the season.

Health.—The climate and particularly the outdoor life are highly invigorating and conducive to health, but should the need arise, any member of the station is entitled to medical attention, without charge, by the staff physician who also inspects and regulates matters pertaining to general sanitation.

The drinking water is entirely safe.

Recreation. — After the day's work, opportunities for boating, swimming, and fishing, are within easy reach. Bonfires on the beach and other informal gatherings after supper have proved to be pop-

ular diversions. One of the buildings is set aside for social purposes on inclement evenings, while the other laboratories are reserved for those who wish to work. There is no class-work on Saturday afternoons.

FACILITIES FOR INSTRUCTION AND RESEARCH

The buildings of the Station include a large and commodious frame laboratory, two smaller log buildings, a tent laboratory, and an aquarium shelter. These are comfortably fitted with the necessary furniture, and are used for recitations, laboratory work, offices, and research. The equipment of the Station includes a large launch, two portable rowboat motors, five rowboats, various types of nets and seines, traps, cameras, field glasses, compound and dissecting microscopes, and accessories, microtome, and a large supply of minor articles. A good working library is provided. Students expecting to use unusual types of apparatus in their research are invited to correspond with the Director, who will give his attention to their needs.

FEES

Students, except as below, will pay the regular Summer Session fee of $21.00 for the eight weeks and will then be entitled to take courses aggregating eight hours university credit. A charge of $8.00 is made for the use of the scientific equipment. A further charge of $8.00 is made to those students who use the tents provided by the Station. Students may, however, provide their own camp equipment, of such sort as they may choose, and thus save the tent fee.

Students not graduates of the University of Michigan who enroll in the Graduate School will pay, in place of the above fee of $21.00, a fee of $26.00. This fee of $26.00 includes the regular matriculation fee of the University and the fee for the current summer session.

Investigators from other institutions may secure quarters and make use of the facilities of the Station upon payment of a tent and equipment fee of $2.00 per week and a health service fee of $1.00.

APPLICATION AND REGISTRATION*

Since the total number of students that can be accommodated is limited, *immediate application is necessary to insure admission.* Moreover, as efficient field work can be accomplished only with small numbers, it is desired to limit the students in each class to twelve,

* A supplementary announcement, to be had upon application to the Director, gives detailed information concerning the necessary equipment, scientific and personal, the best route to the Station, and other matters not specifically dealt with in the present bulletin.

The Station Launch at the Dock

The Beach on the East Side of the Lake

although this number may be exceeded if absolutely necessary. Inasmuch as students will be received into these courses in the order of application, it is advisable to notify the Director or the several instructors as early as possible.

The courses are given chiefly in the field and for this reason it is impracticable to make changes in the schedule as announced. Students enrolled in the research courses do their work on the most convenient days.

Registration blanks will be filled by each student after arrival at the Station. Students from other institutions may arrange for a transfer of credits through the Director and the Registrar of the University.

COURSES FOR UNDERGRADUATES AND GRADUATES

It is not the purpose of the Station to duplicate the work offered at the University, but to provide facilities for field work of a sort that cannot be so well carried on under urban conditions or with the restrictions imposed by a university schedule. Instruction is limited to the courses announced, but qualified students may arrange to follow other lines by electing the special courses. A student may give his entire time to either botany or zoölogy or may divide it between these subjects, but no student is permitted to take work for more than eight hours University credit. Each of the four-hour courses is planned to occupy one-half the student's time, the two-hour courses, one-quarter; the special courses may take the whole or any part of the time. In all courses, except Plant Anatomy, at least half the time is spent in the field. The work of research students will be arranged in accordance with the nature of the problem selected.

Each course occupies the entire working day assigned to it, and consists of field or laboratory work, supplemented in every case by lectures, recitations, or conferences, and by assigned reading and preparation of reports.

Graduate students, when regularly matriculated in the University and properly registered with the Dean of the Graduate School, may carry on work at the Station which will count toward an advanced degree.

For full information concerning the requirements for advanced degrees, address the Dean of the Graduate School, Ann Arbor, Michigan.

Zoology

101. *The Natural History of Vertebrate Animals.*—The course deals chiefly with fishes, amphibians, and reptiles, not with birds (see Course 107), and only incidentally with mammals. As far as possible representatives of all forms of fishes, amphibians and rep-

tiles occurring in the region are collected, identified and studied in both field and laboratory. Particular attention is given to the ecology of the several species and correlated studies of the food, habitats, enemies and interrelations of the various species are made. The general problems of evolution, distribution and taxonomy are considered as opportunity offers. Although most of the work is given in the field, attention to precise methods of observation and to the correct use of data is required.

Thursday. *Two hours credit.* Assistant Professor ELLIS.

Prerequisite: Elementary collegiate zoölogy.

This course gives one hour credit to graduate students. Such students, wishing full credit, must perform extra work, and will register for Course 101*a*.

103. *The Natural History of Invertebrate Animals with Reference to the Principles of Ecology.*—The course will consist of a careful examination of the typical aquatic habitats of the region. This will involve the collection and identification of forms, the determination of their life histories and structural adaptations and an analysis of the environmental factors, biological and physical, influencing them. In each habitat only those forms will be considered which are of importance in presenting the facts and principles of ecology. Especial attention will be given to analysis of those factors in the lake which make it a suitable abode for organisms. Each student will have actual experience in determining depths, temperature, transparency to light, food content of the water and such other matters as fall within the scope of this analysis. The field work will be supplemented by lectures and conferences, so that at the end of the season the student will have a fairly comprehensive picture of the conditions of aquatic life and how animals are affected by these conditions.

The course is planned particularly for prospective teachers of biology.

Wednesday and Friday. *Four hours credit.* Assistant Professor WELCH.

Prerequisite: Elementary collegiate zoölogy.

This course gives two hours credit to graduates, who may obtain full credit by registration in Course 103*a*.

105. *The Natural History of Insects.* — This course is intended to give the student a general acquaintance with the insects of the region and to afford opportunity for the study of the various forms in their native habitats. Field studies are made of the life histories, habits, and activities of insects belonging to various orders. Emphasis is placed upon the relation of insects to their environment, and upon economic relations. Some work on the morphology and physiology of insects is included. Instruction is given in the approved meth-

ods of collecting and preserving insects in all stages of development. Opportunity is afforded to form individual collections of properly determined specimens.

Monday. *Two hours credit.* Assistant Professor ELLIS.

Prerequisite: Elementary collegiate zoölogy.

This course gives one hour credit to graduates. Students desiring full credit, must complete extra work, and will register for Course 105*a*.

107. *Ornithology.*—In this course, birds are studied mostly during their breeding season, but in the latter part of the session, there are opportunities for studying early autumnal migration movements. Special attention is given to identification of birds and methods of field study. Bird behavior and especially nesting habits are considered. Lantern slides are used in studying identification characteristics and for illustrating bird behavior. The bird fauna is ample for the course, and it is interesting especially because of the northern species breeding here under wild conditions. There are conferences when various ornithological topics are discussed.

Saturday morning, and two or three early morning trips to be arranged. *Two hours credit.* Mr. HUSSEY.

Prerequisite: An elementary collegiate course in zoölogy, botany or biology.

Course 107 does not give credit to graduates.

109. *Special and Research Work in Zoölogy.*—Students who do not find under the formally announced courses in zoölogy, work suited to their needs or attainments, may, if properly prepared, elect Course 109. Those qualified to work independently will find numerous problems to engage their attention. Every encouragement in the direction of profitable research and the publication of results will be given. Advanced students as well as independent investigators who can foresee special needs are advised to notify the Director who will endeavor to provide the necessary facilities.

Students who are beginning research, or who work under direction are recommended to choose subjects in the following fields:

(a) *The Morphology, Taxonomy, and Life Histories of Parasitic Worms.* Director LA RUE.

(b) *The Fishes and Insects.* Assistant Professor ELLIS.

(c) *The Annelid Worms, Aquatic Lepidoptera, and Aquatic Diptera.* Associate Professor WELCH.

Days to be arranged. *Two, four, six, or eight hours credit.*

Prerequisite: Admission only by permission of the instructors in charge.

This course gives full credit to graduates.

Botany

[102. *Field and Forest Botany.*—Not given in 1918.]

104. *Systematic Botany.* — The chief aim of this course is to acquaint the student with the flora about the Station and to give him facility in the identification of plants by the Manual. About one hundred species of plants are identified in the field, the characteristics of the more important families of flowering plants are learned, and the general principles of the classification of plants are presented. There is excellent opportunity for the collection and preparation of material for the herbarium. Students who complete this course successfully should be able to identify readily the native flora in any section of the country.

Tuesday. *Two hours credit.* Dr. EHLERS.

Prerequisite: Botany 102 at the station or a course in elementary collegiate botany.

This course gives one hour of credit to graduate students. Students wishing two hours of graduate credit must perform additional work and will register for Course 104*a*.

106. *Ecology.*—This course serves as a general introduction to ecological field work and the methods of ecological research, with particular reference to the study of plant associations. Practice is given in the recognition of associations, the determination and description of their structure and successful relations, and the measurement of some environmental factors. Particular attention is given to the dynamic factors of the environment, to their effect on the present structure and future development of the plant community, and to the role of the individual plant in promoting or retarding the effects. Because of the large number of associations in the region, it is impossible to study more than the most important ones. These include the aspen association, the hardwood forest, the tamarack and sphagnum bog, the arbor-vitæ bog, and the sand dunes, lagoons, and beaches along the lake shore.

Tuesday and Thursday. *Four hours credit.* Assistant Professor GATES.

Prerequisite: Elementary collegiate botany but it is recommended that the student have had systematic botany and plant anatomy.

This course gives two hours credit to graduate students, who may receive full credit by registration in Course 106*a*.

108. *Plant Anatomy.*—The general facts and principles of plant anatomy are presented by means of material collected and prepared by each student individually. Students thus have practice in the preservation of material, methods of fixation, section cutting, and staining. Every facility will be given for the collection and pres-

ervation of material for use in teaching or in research. The topics chiefly considered are the anatomy and secondary thickening of the stem and the structure of the root and the foliage leaf. The modifications of the structure of the leaf in different environments will be considered.

Monday. *Two hours credit.* Dr. EHLERS and Professor GLEASON.

Prerequisite: Elementary collegiate botany.

This course gives one hour of credit to graduate students. Students wishing two hours of graduate credit must perform additional work and will register for Course 108*a*.

110. *Advanced Systematic Botany.* — In the field the student will have practice in the identification and recognition of plants belonging to the more difficult groups, including grasses, sedges, pondweeds, and others, and in the identification of plants from fruit or leaf characters only. The characteristics of these families will be presented both in the field and by lecture. The lectures will also consider the evolution and relationships of the angiosperms, the rules of botanical nomenclature, and the present trend of systematic botany.

Thursday. *Two hours credit.* Dr. EHLERS.

Prerequisite: Botany 104 at the Station or Botany 8 at the University, or equivalent preparation elsewhere.

This course gives full credit to graduate students.

112. *Special and Research Work in Botany.*—Students who have taken Courses 104 or 106 or have had adequate botanical experience elsewhere, will find at the Biological Station excellent opportunities for further study or research in many lines of botany. Undergraduates, or graduates beginning research and consequently needing personal direction, are advised to choose a problem along ecological, anatomical, or systematic lines. Advanced students or independent investigators are free to choose problems in any line of botany, and every effort is made to provide them with the necessary facilities and equipment for their work.

Days to be arranged. *Two, four, six, or eight hours credit.* Professor GLEASON, Assistant Professor GATES and Dr. EHLERS.

Prerequisite: Admission only by arrangement with the instructors in charge.

This course gives full credit to graduate students.

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MARGARET T. GATES, *Dean of Women.*

The Biological Station of the University of Michigan

A station for instruction and research in biology will be maintained by the University of Michigan, for the eleventh season, as a part of its regular Summer Session, during the eight weeks from June 30 to August 22, inclusive, 1919.

LOCATION

The Station is located near the Engineering Camp of the University on a tract of about 3200 acres of land owned by the University and stretching from Douglas Lake to Burt Lake in Cheboygan County, Michigan, 17 miles south of the Straits of Mackinac. This region, diversified by hills and valleys, was formerly covered by forests of hardwoods and conifers. Small tracts of the former still remain. It contains many lakes of clear water, unsurpassed in the state for size, depth, and beauty of setting. The elevation of the camp, between one and two hundred feet above Lake Michigan, insures cool nights.

Six miles to the west of the camp on the Grand Rapids and Indiana Railway is the nearest railroad station, Pellston, a town of some 1,300 inhabitants, with a bank and a variety of retail establishments. Topinabee, on the Michigan Central Railway, is 8 miles from the camp. Fifteen miles to the northeast, also on the Michigan Central Railway, is Cheboygan. A state road connects these points and passes near the laboratory. Except for two small summer resorts on Douglas Lake the region for miles about is almost uninhabited. Douglas Lake is two and one-half miles wide and nearly four miles long. Its shores are everywhere wooded, in some places low and receding, in others rising in terraced bluffs 70 feet in height. The beach is of clean sand and the lake bottom slopes gradually into deep water.

OPPORTUNITIES FOR BIOLOGICAL WORK

The location of the Biological Station in the transition zone between the northern coniferous forest area and the central deciduous forest of hardwood vegetation makes easy the study of both types of vegetational associations. No other biological station in the United States is favorably located for this kind of study.

Within the region are three well marked soil types each bearing its peculiar type of vegetation. The better soil of the uplands is clayey, the poorer sandy. The clay soil supports the hardwood forest while the sandy soils were formerly covered with pine forests. The low lands are usually bogs and these support a characteristic vegetation. The lake shores, river banks and occasional small sand dunes support a characteristic but less abundant vegetation. The beech-maple or hard-wood forest is similar to that occurring throughout the state of Michigan. Its characteristic trees are sugar maple, beech, hemlock, and white ash. Several small forests of this type may be found within walking distance of the Station but the best hardwood forests of the region lie along the Jackson and Tindle Lumber Railway west of Pellston. In place of the pine forests which formerly occupied the sandy soils are now found the aspens which find ready access to the cut-over and burned-over lands. These are small short-lived trees which are important in the reforestation of the burned-over areas. Among the aspens are frequent pine trees ranging in size from seedlings to cone bearing trees. With protection from fire such lands will in course of time become reforested with pines.

Within the region are many bogs in various stages of development. In the bogs occur many white cedars (arbor vitae), tamaracks, spruces, and balsams. The ground flora is typical and quite northern. It contains among other plants several species of orchids, and the interesting insect-catching sundew and pitcher plants. The lake shore, pond and river banks furnish interesting species. Most of the streams of the region are small and they vary in character of flow from sluggish to rapid. The lakes vary in size from very small ones without outlet to Burt Lake, nearly 20 miles long, to Lakes Michigan and Huron. Station activities do not ordinarily include the last two lakes. On the shores of Douglas Lake are a few small sand dunes. Dune work is usually supplemented by a trip to the large dunes along Lake Michigan.

This region in which the Station is located thus offers considerable diversity of original conditions which have in many respects undergone modifications by fire, permitting great vegetational changes which admit of a very adequate presentation of ecological principles.

Among the problems in plant ecology suggested by the region are: the development of certain habitats, successional relationships, correlation of vegetation and evaporation, physiological limitations of habitats and species, growth increments under varying conditions, changes in soil and vegetation due to cutting, burning, draining, planting, and seeding.

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The Station Launch at the Dock

The Beach on the East Side of the Lake

sandy aspen associations. Rusts, smuts and other parasitic fungi infest a vast variety of hosts, offering an abundance of material for the investigator. The study of the Cryptogams is practically a virgin field at the Station, little work having been done in that line. There is, however, a collection of lichens and mosses for comparative study.

For the study of animals the region is probably not quite so well adapted as it is for the study of plants. The fauna is not as rich as it is in the southern parts of the state. Mammals are few, the number of species of amphibians, reptiles and fish is small but the number of individuals is sufficient for good collecting. The fish fauna of the chain of lakes of which Douglas Lake is a part and their tributaries is interesting and well worth study in comparison with the fauna of the Great Lakes. Birds are sufficiently numerous and the range of their habitats within easy reach of the Station is such that good work can be done. Numerous problems dealing with the ecology of birds, their behavior, and the activities of breeding and nesting birds await attention. A fair proportion of the birds which nest there are known to most ornithologists as migrants only.

The invertebrate fauna is relatively much richer than the vertebrate fauna. There are many terrestrial and aquatic molluscs and many crustacea, including the plankton forms. Vincent, Monroe, and Lancaster Lakes which are in easy reach of the Station furnish many conditions not found in Douglas Lake for Plankton and other organisms. Sponges and bryozoans are fairly common, while the common fresh water Hydra appears at times in countless numbers and furnishes good material for experimental work. Insect life abounds in the many varied habitats of the region. There are a number of aquatic annelids of considerable interest but the number of terrestrial annelids is greatly restricted by the prevalence of the sandy soil.

Parasitism in animals is extremely common. Parasitic worms are abundant both in species and individuals. All the vertebrates which frequent water serve as hosts for parasites, both adult and immature, while the numerous invertebrates yield young stages of many of the worms. Owing to the moderate size of the lake the collection of hosts is easy. With pens, cages, and aquaria now available the study of life-histories by means of feeding experiments is rendered possible. Practically no study has been made of parasitic worms infesting those vertebrates not frequenting water. The parasitic Protozoa of the region have been but little studied.

The very fact that the fauna is not as rich as it is in many places simplifies many of the problems of the zoölogist. Here the ecology of aquatic invertebrates may be studied under most excellent conditions. The habitats are almost typical, are readily accessible, and the student is not overwhelmed with the multiplicity and diversity of forms to be found in some localities.

The attractions of a northern flora, an adequate though not complex fauna together with an excellent climate, good conditions for

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Health.—The climate and particularly the outdoor life are highly invigorating and conducive to health, but should the need arise, any member of the station is entitled to medical attention, without charge, by the staff physician who makes daily visits to the camp and who may be called at any time. He also inspects and regulates matters pertaining to general sanitation.

The drinking water is cold, of fine quality, and entirely safe.

Recreation.—After the day's work, opportunities for boating, swimming, and fishing, are within easy reach. Bonfires on the beach and other informal gatherings after supper have proved to be popular diversions. Students are encouraged to use the boats which are placed freely at the disposal of students and others when not in use for class or other study purposes. The log laboratory has been set aside as a recreation center for use at all times. It is provided with a stove, tables and chairs, and is comfortable in cold or hot weather. Here is located the camp post office.

Circular of Information.—A special circular has been prepared by the Director in collaboration with students and staffmembers which gives detailed information in regard to mail, express, freight, baggage, directions as to how to get to the Station, personal equipment (being detailed lists of bedding and clothing for men and women), and supplies required for courses. All students who contemplate coming to the Station should secure this circular which may be had upon application to the Director at Ann Arbor, and no student should arrive at the Station without having had it.

Houghton Hall, One of the Laboratories

The Tent and Log Laboratories, and "Totem" Pole

FEES AND EXPENSES

The regular Summer Session fee of $21.50 will be paid by all undergraduate students, and by all graduate students who have been registered in the Graduate School prior to the Summer Session. Graduate students (not graduates of the University of Michigan and not previously registered in the Graduate School) will pay a fee of $26.50. All students will pay an equipment fee of $8.00 and a tent fee of $8.00. Those furnishing their own tents may save the tent fee.

Investigators will pay a fee of $2.00 per week, the health service fee of $1.50 which entitles them to the services of the Station physician without further charge. They will also pay the usual commissary fee or a proper portion thereof for a shorter time than the full session.

The commissary fee is $42.00, payable on arrival to the representative of the commissary department.

The total cost for the session exclusive of travelling expenses and clothing need not exceed $95.00. A limited number of students may earn a portion of their expenses by performing certain duties for the Station or the Mess. Arrangements for this must be made with the Director before arrival at the Station.

APPLICATION AND REGISTRATION

Since the total number of students that can be accommodated is limited, *immediate application (by letter only) is necessary to insure admission.* Moreover, as efficient field work can be accomplished only with small numbers, it is desired to limit the students in each class to twelve, although this number may be exceeded if absolutely necessary. Inasmuch as students will be received into these courses in the order of application, it is advisable to notify the Director or the several instructors as early as possible.

The courses are given chiefly in the field and for this reason it is impracticable to make changes in the schedule as announced. Students enrolled in the research courses do their work on the most convenient days.

Registration blanks will be filled by each student on Monday afternoon, June 30. Undergraduate students from other institutions may arrange for the transfer of credits by applying to the Registrar of the University, at Ann Arbor. Graduate students wishing transfer of credits should make application to the Dean of the Graduate School.

COURSES FOR UNDERGRADUATES AND GRADUATES

It is not the purpose of the Station to duplicate the work offered at the University, but to provide facilities for field work of a sort that cannot be so well carried on under urban conditions or with the restrictions imposed by a university schedule. Instruction is limited to the courses announced, but qualified students may arrange to follow other lines by electing the special courses. A student may give his entire time to either botany or zoölogy or may divide it between these subjects, but no student is permitted to take work for more than eight hours University credit. Each of the four-hour courses is planned to occupy one-half the student's time, the two-hour courses, one-quarter; the special courses may take the whole or any part of the time. In all courses, except Plant Anatomy, at least half the time is spent in the field. The work of research students will be arranged in accordance with the nature of the problem selected.

Each course occupies the entire working day assigned to it, and consists of field or laboratory work, supplemented in every case by lectures, recitations, or conferences, and by assigned reading and preparation of reports. Each course normally requires time for reading and study in addition to the hours scheduled for field and laboratory work. It will not be possible for students carrying full work (eight hours) to spend their week ends away from the Station.

Graduate students, when regularly matriculated in the University and properly registered with the Dean of the Graduate School, may carry on work at the Station which will count toward an advanced degree.

For full information concerning the requirements for advanced degrees, address the Dean of the Graduate School, Ann Arbor, Michigan.

Zoology

101. *The Natural History of Vertebrate Animals.*—The course deals chiefly with fishes, amphibians, and reptiles, not with birds (see Course 107), and only incidentally with mammals. As far as possible representatives of all forms of fishes, amphibians and reptiles occurring in the region are collected, identified and studied in both field and laboratory. Particular attention is given to the ecology of the several species and correlated studies of the food, habitats, enemies and interrelations of the various species are made. The general problems of evolution, distribution and taxonomy are considered as opportunity offers. Although most of the work is given in

the field, attention to precise methods of observation and to the correct use of data is required.

Thursday. *Two hours credit.* Professor SMITH.

Prerequisite: Elementary collegiate zoölogy.

This course gives one hour credit to graduate students. Such students, wishing full credit, must perform extra work, and will register for Course 101*a*.

103. *The Natural History of Invertebrate Animals with Reference to the Principles of Ecology.*—The course will consist of a careful examination of the typical aquatic habitats of the region. This will involve the collection and identification of forms, the determination of their life histories and structural adaptations and an analysis of the environmental factors, biological and physical, influencing them. In each habitat only those forms will be considered which are of importance in presenting the facts and principles of ecology. Especial attention will be given to analysis of those factors in the lake which make it a suitable abode for organisms. Each student will have actual experience in determining depths, temperature, transparency to light, food content of the water and such other matters as fall within the scope of this analysis. The field work will be supplemented by lectures and conferences, so that at the end of the season the student will have a fairly comprehensive picture of the conditions of aquatic life and how animals are affected by these conditions.

The course is planned for prospective teachers of biology as well as for those who plan to become professional zoölogists.

Wednesday and Friday. *Four hours credit.* Assistant Professor WELCH.

Prerequisite: Elementary collegiate zoölogy.

This course gives two hours credit to graduates, who may obtain full credit by registration in Course 103*a*.

105. *The Natural History of Insects.*—This course is intended to give the student a general acquaintance with the insects of the region and to afford opportunity for the study of the various forms in their native habitats. Field studies are made of the life histories, habits, and activities of insects belonging to various orders. Emphasis is placed upon the relation of insects to their environment, and upon economic relations. Some work on the morphology and physiology of insects is included. Instruction is given in the approved methods of collecting and preserving insects in all stages of development. Opportunity is afforded to form individual collections of properly determined specimens.

Monday. *Two hours credit.* Mr. STONER.

Prerequisite: Elementary collegiate zoölogy.

This course gives one hour credit to graduates. Students desiring full credit, must complete extra work, and will register for Course 105*a*.

A Class at Work

A Welcome Diversion After the Day's Work

107. *Ornithology.*—In this course, birds are studied mostly during their breeding season, but in the latter part of the session, there are opportunities for studying early autumnal migration movements. Special attention is given to identification of birds and methods of field study. Bird behavior and especially nesting habits are considered. Lantern slides are used in studying identification characteristics and for illustrating bird behavior. The bird fauna is ample for the course, and it is interesting especially because of the northern species breeding here under wild conditions. There are conferences at which various ornithological topics are discussed.

Saturday morning, two or three early morning trips and conferences to be arranged. *Two hours credit.* Mr. STONER.

Prerequisite: An elementary collegiate course in zoölogy, botany or biology.

Course 107 does not give credit to graduates.

109. *Special and Research Work in Zoölogy.*—Students who do not find under the formally announced courses in zoölogy, work suited to their needs or attainments, may, if properly prepared, elect Course 109. Those qualified to work independently will find numerous problems to engage their attention. Every encouragement in the direction of profitable research and the publication of results will be given. Advanced students as well as independent investigators who can foresee special needs are advised to notify the Director who will endeavor to provide the necessary facilities.

Students who are beginning research, or who work under direction are recommended to choose subjects in the following fields:

(a) *The Morphology, Taxonomy, and Life Histories of Parasitic Worms.* Director LA RUE.

(b) *The Fishes and Plankton Organisms.* Professor SMITH.

(c) *The Annelid Worms, Aquatic Lepidoptera, and Aquatic Diptera,* Assistant Professor WELCH.

Days to be arranged. *Two, four, six, or eight hours credit.*

Prerequisite: Admission only by permission of the instructors in charge.

This course gives full credit to graduates.

Botany

[102. *Field and Forest Botany.*—Not given in 1919.]

104. *Systematic Botany.*—The chief aim of this course is to acquaint the student with the flora about the Station and to give him facility in the identification of plants by the Manual. About one hundred species of plants are identified in the field, the characteristics of the more important families of flowering plants are

learned, and the general principles of the classification of plants are presented. There is excellent opportunity for the collection and preparation of material for the herbarium. Students who complete this course successfully should be able to identify readily the native flora in any section of the country.

Tuesday. *Two hours credit.* Dr. EHLERS.

Prerequisite: Botany 102 at the station or a course in elementary collegiate botany.

This course gives one hour of credit to graduate students. Students wishing two hours of graduate credit must perform additional work and will register for Course 104*a*.

106. *Ecology.*—This course serves as a general introduction to ecological field work and the methods of ecological research, with particular reference to the study of plant associations. Practice is given in the recognition of associations, the determination and description of their structure and successful relations, and the measurement of some environmental factors. Particular attention is given to the dynamic factors of the environment, to their effect on the present structure and future development of the plant community, and to the role of the individual plant in promoting or retarding the effects. Because of the large number of associations in the region, it is impossible to study more than the most important ones. These include the aspen association, the hardwood forest, the tamarack and sphagnum bog, the arbor-vitæ bog, and the sand dunes, lagoons, and beaches along the lake shore.

Wednesday and Friday. *Four hours credit.* Assistant Professor GATES.

Prerequisite: Elementary collegiate botany, but it is recommended that the student have had systematic botany and plant anatomy.

This course gives two hours credit to graduate students, who may receive full credit by registration in Course 106*a*.

108. *Plant Anatomy.*—The general facts and principles of plant anatomy are presented by means of material collected and prepared by each student individually. Students thus have practice in the preservation of material, methods of fixation, section cutting, and staining. Every facility will be given for the collection and preservation of material for use in teaching or in research. The topics chiefly considered are the anatomy and secondary thickening of the stem and the structure of the root and the foliage leaf. The modifications of the structure of the leaf in different environments will be considered.

Monday. *Two hours credit.* Dr. QUICK.

Prerequisite: Elementary collegiate botany.

This course gives one hour credit to graduate students. Students wishing two hours of graduate credit must perform additional work and will register for Course 108*a*.

110. *Advanced Systematic Botany.*—In the field the student will have practice in the identification and recognition of plants belonging to the more difficult groups, including grasses, sedges, pondweeds, and others, and in the identification of plants from fruit or leaf characters only. The characteristics of these families will be presented both in the field and by lecture. The lectures will also consider the evolution and relationships of the angiosperms, the rules of botanical nomenclature, and the present trend of systematic botany.

Thursday. *Two hours credit.* Dr. EHLERS.

Prerequisite: Botany 104 at the Station or Botany 8 at the University, or equivalent preparation elsewhere.

This course gives full credit to graduate students.

112. *Special and Research Work in Botany.*—Students who have taken Courses 104 or 106 or have had adequate botanical experience elsewhere, will find at the Botanical Station excellent opportunities for further study or research in many lines of botany. Undergraduates, or graduates beginning research and consequently needing personal direction, are advised to choose a problem along ecological, anatomical, or systematic lines. Advanced students or independent investigators are free to choose problems in any line of botany, and every effort is made to provide them with the necessary facilities and equipment for their work.

Days to be arranged. *Two, four, six, or eight hours credit.* Assistant Professor GATES and Dr. EHLERS.

Prerequisite: Admission only by arrangement with the instructors in charge.

This course gives full credit to graduate students.

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ENTERED AS SECOND-CLASS MATTER AT THE POSTOFFICE AT ANN ARBOR, MICHIGAN.

UNIVERSITY OF MICH. 18

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The Catalogue of the University.

The Annual Announcements of the College of Literature, Science, and the Arts, the Colleges of Engineering and Architecture, the Medical School, the Law School, the College of Pharmacy, the Homœopathic Medical School, the College of Dental Surgery, the Graduate School, and the Summer Session.

Other Announcements of the several departments of instruction, Reports and Communications of University officers, etc.

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UNIVERSITY BULLETIN

NEW SERIES, VOL. XXI, NO. 37. MAY 1, 1920.

UNIVERSITY OF MICHIGAN
SUMMER SESSION

ANNOUNCEMENT
FOR THE
BIOLOGICAL STATION

EIGHT WEEKS, JUNE 28—AUGUST 20

TWELFTH SEASON, 1920

ANN ARBOR
PUBLISHED BY THE UNIVERSITY
1920

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GEORGE E. NICHOLS, Ph.D., *Assistant Professor of Botany in Yale University, Assistant Professor of Botany.*

JOHN HENRY EHLERS, Ph.D., *Instructor in Botany in the University of Michigan, Instructor in Botany.*

DAYTON STONER, Ph.D., *Instructor in Zoölogy in the State University of Iowa, Instructor in Zoölogy.*

WARREN E. FORSYTHE, M.D., *Director of the University of Michigan Health Service, Physician to the Biological Station.*

MARGARET T. GATES, *Dean of Women.*

The Biological Station of the University of Michigan

A station for instruction and research in biology will be maintained by the University of Michigan, for the twelfth season, as a part of its regular Summer Session, during the eight weeks from June 28 to August 20, inclusive, 1920.

LOCATION

The Station is located near the Engineering Camp of the University on a tract of about 3200 acres of land owned by the University and stretching from Douglas Lake to Burt Lake in Cheboygan County, Michigan, 17 miles south of the Straits of Mackinac. This region, diversified by hills and valleys, was formerly covered by forests of hardwoods and conifers. Small tracts of the former still remain. It contains many lakes of clear water, unsurpassed in the state for size, depth, and beauty of setting. The elevation of the camp, between one and two hundred feet above Lake Michigan, insures cool nights.

Six miles to the west of the camp on the Grand Rapids and Indiana Railway is the nearest railroad station, Pellston, a town of some 1,300 inhabitants, with a bank and a variety of retail establishments. Topinabee, on the Michigan Central Railway, is 8 miles from the camp. Fifteen miles to the northeast, also on the Michigan Central Railway, is Cheboygan. A state road connects these points and passes near the laboratory. Except for two small summer resorts on Douglas Lake the region for miles about is almost uninhabited. Douglas Lake is two and one-half miles wide and nearly four miles long. Its shores are everywhere wooded, in some places low and receding, in others rising in terraced bluffs 70 feet in height. The beach is of clean sand and the lake bottom slopes gradually into deep water.

OPPORTUNITIES FOR BIOLOGICAL WORK

The location of the Biological Station in the transition zone between the northern eastern coniferous forest area and the central deciduous forest of hardwood vegetation makes easy the study of both types of vegetational associations. No other biological station in the United States is favorably located for this kind of study.

Within the region three types of vegetation stand out very conspicuously, each covering considerable area. The better soil of the uplands is somewhat clayey and loamy and supports the "hardwood" forest, containing such trees as sugar maple, beech, hemlock, white ash and basswood. Areas showing various stages of second growth as well as virgin conditions are within easy reach, although the best forests are about 9 miles west of the station.

The poorer soil of the uplands is very sandy. Formerly support-

ing a pine forest, now, following cutting and repeated burning, it is covered with aspens. These are small, short-lived trees, which are important in the revegetation of burnt over areas. Among the aspens are frequent pines ranging in size from seedlings to cone-bearing trees. With sufficient protection from fires such areas are due to be reforested with pine in a comparatively short time.

The lowlands are usually occupied by bogs exhibiting various stages of development. Such trees as white cedar (arbor vitae), tamarack, spruces and balsam are abundant. The flora is typically northern. It includes several orchids, insect-catching plants, as the pitcher plant and sundew, and the dwarf mistletoe.

Ponds, several lakes, mostly small, and a few streams, all of which are small, furnish a diverse series of habitats, each with its characteristic flora.

Sand dunes along Lake Michigan supplement the very small ones in the Douglas Lake region.

The region in which the Station is located thus offers considerable diversity of original conditions which have in many respects undergone modifications by fire, permitting great vegetational changes which admit of a very adequate presentation of ecological principles.

Among the problems in plant ecology suggested by the region are: the development of certain habitats, successional relationships, correlation of vegetation and evaporation, physiological limitations of habitats and species, growth increments under varying conditions, changes in soil and vegetation due to cutting, burning, draining, planting, and seeding.

The region likewise offers a rich field for scientific work with the Cryptogams. Algae abound in the lakes, pools and streams; lichens, mosses, ferns, and the fern allies may be found in abundance in habitats varying from Sphagnum and Thuja bogs to the dry, sandy aspen associations. Rusts, smuts and other parasitic fungi infest a vast variety of hosts, offering an abundance of material for the investigator. The study of the Cryptogams is practically a virgin field at the Station, little work having been done in that line. There is, however, a collection of lichens and mosses for comparative study.

For the study of animals the region is probably not quite so well adapted as it is for the study of plants. The fauna is not as rich as it is in the southern parts of the state. Mammals are few, the number of species of amphibians, reptiles and fish is small but the number of individuals is sufficient for good collecting. The fish fauna of the chain of lakes of which Douglas Lake is a part and their tributaries is interesting and well worth study in comparison with the fauna of the Great Lakes. Birds are sufficiently numerous and the range of their habitats within easy reach of the Station is such that good work can be done. Numerous problems dealing with the ecology of birds, their behavior, and the activities of breeding and nesting birds await attention. A fair proportion of the birds which nest there are known to most ornithologists as migrants only.

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Class Working at a Beach Pool

An Old Beach Pool

brate fauna. There are many terrestrial and aquatic molluscs and many crustacea, including the plankton forms. Vincent, Munro and Lancaster Lakes which are in easy reach of the Station furnish many conditions not found in Douglas Lake for Plankton and other organisms. Sponges and bryozoans are common, while the common fresh water Hydra is usually present during the first half of the summer in countless numbers and furnishes good material for experimental work. Insect life abounds in the many varied habitats of the region. There are a number of aquatic annelids of considerable interest but the number of terrestrial annelids is greatly restricted by the prevalence of the sandy soil. In its numerous aquatic habitats Protozoa are known to be abundant although no careful study has yet been made of this group in the region.

Parasitism in animals is extremely common. Parasitic worms are abundant both in species and individuals. All the vertebrates which frequent water serve as hosts for parasites, both adult and immature, while the numerous invertebrates yield young stages of many of the worms. Owing to the moderate size of the lake the collection of hosts is easy. Pens, cages, and aquaria are now available, thus making possible the study of life histories by means of feeding experiments. Practically no study has been made of parasitic worms infesting those vertebrates not frequenting water. The parasitic Protozoa of the region have been but little studied.

The very fact that the fauna is not as rich as it is in many places simplifies many of the problems of the zoölogist. This statement applies with special emphasis to the work of the parasitologist. The ecology of aquatic invertebrates may be studied under most excellent conditions. The habitats are almost typical, are readily accessible, and the student is not overwhelmed with the multiplicity and diversity of forms to be found in some localities.

The attractions of a northern flora, an adequate though not complex fauna together with an excellent climate, good conditions for study, freedom from interruptions, freedom from summer visitors, and freedom from the exactions of a university schedule and from the conditions of urban life make the Station a good place for study and research.

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Health.—The climate and particularly the outdoor life are highly invigorating and conducive to health, but should the need arise, any member of the Station is entitled to medical attention, without charge, by the staff physician who makes daily visits to the camp and who may be called at any time. He also inspects and regulates matters pertaining to general sanitation.

The drinking water is cold, of fine quality, and entirely safe.

Recreation. — After the day's work, opportunities for boating, swimming, and fishing are within easy reach. Bonfires on the beach and other informal gatherings after supper have proved to be popular diversions. Students are encouraged to use the boats which are placed freely at the disposal of students and others when not in use for class or other study purposes. The log laboratory has been set aside as a recreation center for use at all times. It is provided with a stove, tables and chairs, and is comfortable in cold or hot weather. Here is located the camp post office.

Circular of Information. — A mimeographed circular has been prepared by the Director in collaboration with students and staff-members which gives detailed information in regard to mail, express, freight, baggage, directions as to how to get to the Station, personal equipment (being detailed lists of bedding and clothing for men and women), and supplies required for courses. All students and others who contemplate coming to the Station should secure this circular which may be had upon application to the Director at Ann Arbor, and no student should arrive at the Station without having had it.

FEES AND EXPENSES

The regular Summer Session fee of $26.50 will be paid by all undergraduate students, and by all graduate students who have been registered in the Graduate School prior to the Summer Session. Graduate students (not graduates of the University of Michigan and not previously registered in the Graduate School) will pay a fee of $31.50. All students will pay an equipment fee of $8.00 and a tent fee of $8.00. Those furnishing their own tents may save the tent fee.

Investigators will pay a fee of $2.00 per week, the health service fee of $1.50 which entitles them to the services of the Station physician without further charge. They will also pay the usual commissary fee or a proper portion thereof for a shorter time than the full session.

The commissary fee is $48.00, payable on arrival to the representative of the commissary department.

The total cost for the session exclusive of travelling expenses and clothing need not exceed $125.00. A limited number of students

"Ladyville," The Quarters Assigned to Women

Houghton Hall, One of the Laboratories

may earn a portion of their expenses by performing certain duties for the Station or the mess. Arrangements for this must be made with the Director before arrival at the Station.

APPLICATION AND REGISTRATION

Since the total number of students that can be accommodated is limited, *immediate application (by letter only) is necessary to insure admission*. Moreover, as efficient field work can be accomplished only with small numbers, it is desired to limit the students in each class to twelve, although this number may be exceeded if absolutely necessary. Inasmuch as students will be received into these courses in the order of application, it is advisable to notify the Director as early as possible.

The courses are given chiefly in the field and for this reason it is impracticable to make changes in the schedule as announced. Students enrolled in the research courses do their work on the most convenient days.

Registration blanks will be filled by each student on Monday afternoon, June 28.

TRANSFER OF CREDITS

Since the Biological Station is an integral part of the University of Michigan, work done there is accepted by the colleges and universities of this country. Undergraduates desiring transfer of credits should apply to the Registrar; graduates should apply to the Dean of the Graduate School, University of Michigan.

ADVANCED DEGREES

Graduate students, when regularly matriculated in the University and properly registered with the Dean of the Graduate School, may carry on work at the Station which will count toward an advanced degree.

The Master's degree may usually be secured by properly qualified graduates of other institutions upon the completion of four summer sessions spent in residence at the University. Candidates who propose to pursue work in Zoölogy or Botany and who have had broad training may, after consultation or correspondence with the Dean of the Graduate School, be permitted to fulfill the entire residence requirement by study at the Biological Station.

For full information concerning the requirements for advanced degrees, address the Dean of the Graduate School, University of Michigan, Ann Arbor.

SPECIAL LECTURES

A series of special lectures on subjects of general interest to students of biological sciences will be given by members of the teaching staff and visiting scientists. A large proportion of these lectures will be illustrated. While not following a fixed schedule these lectures will usually fall on Sunday evening.

COURSES FOR UNDERGRADUATES AND GRADUATES

It is not the purpose of the Station to duplicate the work offered at the University, but to provide facilities for field work of a sort that cannot be so well carried on under urban conditions or with the restrictions imposed by a university schedule. Instruction is limited to the courses announced, but qualified students may arrange to follow other lines by electing the special courses. A student may give his entire time to either botany or zoölogy or may divide it between these subjects, but no student is permitted to take work for more than eight hours University credit. Each of the four-hour courses is planned to occupy one-half the student's time, the two-hour courses, one-quarter; the special courses may take the whole or any part of the time. In all courses, except Plant Anatomy, at least half the time is spent in the field. The work of research students will be arranged in accordance with the nature of the problem selected.

Each course occupies the entire working day assigned to it, and consists of field or laboratory work, supplemented in every case by lectures, recitations, or conferences, and by assigned reading and preparation of reports. Each course normally requires time for reading and study in addition to the hours scheduled for field and laboratory work. It will not be possible for students carrying full work (eight hours) to spend their week ends away from the Station.

Zoology

101. *The Natural History of Vertebrate Animals.*—The course deals chiefly with fishes, amphibians, and reptiles, not with birds (see Course 107), and only incidentally with mammals. As far as possible representatives of all forms of fishes, amphibians and reptiles occurring in the region are collected, identified and studied in both field and laboratory. Particular attention is given to the ecology of the several species and correlated studies of the food, habitats, enemies and interrelations of the various species are made. The general problems of evolution, distribution and taxonomy are considerd as opportunity offers. Although most of the work is given in the field, attention to precise methods of observation and to the correct use of data is required.

Thursday. *Two hours credit.* Professor SMITH.

Prerequisites: Elementary collegiate zoölogy.

This course gives one hour credit to graduate students. Such students, wishing full credit, must perform extra work, and will register for Course 101*a*.

103. *The Natural History of Invertebrate Animals with Reference to the Principles of Ecology.*—This course deals mainly with the more important features of animal ecology as exemplified in the aquatic invertebrates of the Douglas Lake region. A detailed study of the typical aquatic habitats is made in connection with the field

and laboratory work, especial attention being given to the lake itself. This involves the collection and identification of animals, the determination of life histories, the study of structural and physiological adaptations, and an analysis of the environmental factors, organic and inorganic, which are operative in each complex. Interdependencies and the dynamic relations existing in the selected habitats are stressed. In general, only those forms which are important in presenting the facts and principles of ecology are considered in detail. Dissolved gases are determined and their biological significance carefully considered. Students have actual experience in the use of methods and equipment employed in the consideration of temperature, depth, transparency, qualitative and quantitative aspects of plankton work, and lake bottom faunas. A series of lectures dealing with the more general, fundamental principles of limnology supplement the field and laboratory work.

The course is planned for prospective teachers of biology as well as for those who plan to become professional zoölogists.

Wednesday and Friday. *Four hours credit.* Assistant Professor WELCH.

Prerequisite: Elementary collegiate zoölogy.

This course gives two hours credit to graduates, who may secure full credit by registration in Course 103*a*.

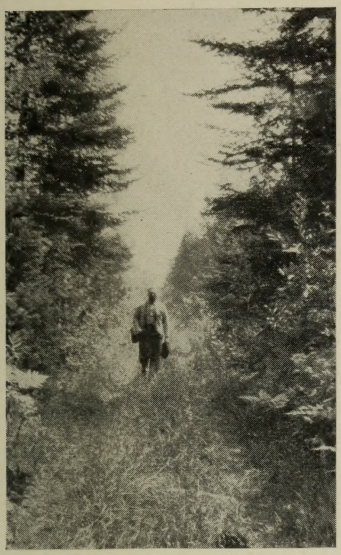
105. *The Natural History of Insects.*—This course is intended to give the student a general acquaintance with the insects of the region and to afford opportunity for the study of the various forms in their native habitats. Field studies are made of the life histories, habits, and activities of insects belonging to various orders. Emphasis is placed upon the relation of insects to their environment, and upon economic relations. Some work on the morphology and physiology of insects is included. Instruction is given in the approved methods of collecting and preserving insects in all stages of development. Opportunity is afforded to form individual collections of properly determined specimens.

Monday. *Two hours credit.* Dr. STONER.

Prerequisite: Elementary collegiate zoölogy.

This course gives one hour credit to graduates. Students desiring full credit must complete extra work, and will register for Course 105*a*.

107. *Ornithology.*—In this course, birds are studied mostly during their breeding season, but in the latter part of the session, there are opportunities for studying early autumnal migration movements. Special attention is given to identification of birds and methods of field study. Bird behavior and especially nesting habits are considered. Lantern slides are used in studying identification characteristics and for illustrating bird behavior. The bird fauna is ample for the course, and it is interesting especially because of the northern species breeding here under wild conditions. There are conferences at which various ornithological topics are discussed.



ROAD THROUGH REESE'S BOG

THE TOTEM POLE, BEARING MONOGRAMS OF GENERATIONS OF STUDENTS

Saturday morning, two or three early morning trips and conferences to be arranged. *Two hours credit.* Dr. STONER.

Prerequisite: An elementary collegiate course in zoölogy, botany or biology.

Course 107 gives one hour credit to graduates. Students desiring full credit must complete extra work, and will register for course 107*a*.

109. *Special and Research Work in Zoölogy.*—Students who do not find under the formally announced courses in zoölogy work suited to their needs or attainments, may, if properly prepared, elect Course 109. Those qualified to work independently will find numerous problems to engage their attention. Every encouragement in the direction of profitable research will be given. The results of each investigation carried on under direction are to be embodied in a report, and if warranted assistance will be given in preparing the report for publication. Advanced students as well as independent investigators who can foresee special needs are advised to notify the Director in ample time to permit the securing of needed apparatus and supplies.

Students who are beginning research, or who require direction are recommended to choose subjects in the following fields:

(a) *The Morphology, Taxonomy, and Life Histories of Parasitic Worms.* Director LA RUE.

(b) *The Fishes and Plankton Organisms.* Professor SMITH.

(c) *The Annelid Worms, Aquatic Lepidoptera, and Aquatic Diptera.* Assistant Professor WELCH.

(d) *The Birds, Hemiptera and Coleoptera.* Dr. STONER.

Days to be arranged. *Two, four, six, or eight hours credit.*

Prerequisite: Admission only by permission of the instructors in charge.

This course gives full credit to graduates.

Botany

102. *Cryptogamic Botany.*—This course is designed to familiarize the student with the salient morphological characteristics of the green algæ, bryophytes, and pteridophytes, and with their taxonomic and economic relations as exemplified by the region in the vicinity of Douglas Lake. Special attention will be given to the distributional peculiarities of various forms and to the method of identifying these, both in the laboratory and in the field.

Saturday. *Two hours credit.* Assistant Professor NICHOLS.

Prerequisite: A course in elementary collegiate botany.

This course gives one hour of credit to graduate students. Students wishing two hours graduate credit must perform additional work and will register for Course 102*a*.

102*b*. *Taxonomy of the Bryophytes.*—A course primarily supplemental to the course on the green cryptograms and concerned largely with the systematic study of the mosses and the liverworts. So far as the time permits, the species growing within reach of the camp will be collected and identified.

Tuesday. *Two hours credit.* Assistant Professor NICHOLS.

Prerequisites: Open to those who are taking course 102, or who have had work on the bryophytes equivalent to that given in that course.

This course gives one hour of credit to graduate students. Students wishing two hours of credit must perform additional work and will register for course 102*c*.

104. *Systematic Botany.* — The chief aim of this course is to acquaint the student with the flora about the Station and to give him facility in the identification of plants by the Manual. About one hundred species of plants are identified in the field, the characteristics of the more important families of flowering plants are learned, and the general principles of the classification of plants are presented. There is excellent opportunity for the collection and preparation of material for an herbarium. Students who complete this course successfully should be able to identify readily the native flora in any section of the country.

Tuesday. *Two hours credit.* Dr. EHLERS.

Prerequisite: A course in elementary collegiate botany.

This course gives one hour of credit to graduate students. Students wishing two hours of graduate credit must perform additional work and will register for Course 104*a*.

106. *Ecology.*—This course serves as a general introduction to ecological field work and the methods of ecological research, with particular reference to the study of plant associations. Practice is given in the recognition of associations, the determination and description of their structure and successful relations, and the measurement of some environmental factors. Particular attention is given to the dynamic factors of the environment, to their effect on the present structure and future development of the plant community, and to the role of the individual plant in promoting or retarding the effects. Because of the large number of associations in the region, it is impossible to study more than the most important ones. These include the aspen association, the hardwood forest, the tamarack and sphagnum bog, the arbor-vitæ bog, and the sand dunes, lagoons, and beaches along the lake shore.

Wednesday and Friday. *Four hours credit.* Assistant Professor GATES.

Prerequisites: Elementary collegiate botany, systematic botany and plant anatomy.

The student is permitted to take one of the latter courses simultaneously with ecology.

This course gives full credit to graduate students, who should register in Course 106*a*.

108. *Plant Anatomy.*—The various tissues and organs of the higher plants are studied with respect to their structure, development, and functions, particular attention being given to the anatomy and developmental relations of herbaceous and woody stems and to modifications in leaf structure which are correlated with differences in environment. So far as possible, material collected by the individual student will be used, and practice in sectioning and staining will constitute an important phase of the laboratory work.

Monday. *Two hours credit.* Assistant Professor NICHOLS.

Prerequisite: Elementary collegiate botany.

This course gives one hour credit to graduate students. Students wishing two hours of graduate credit must perform additional work and will register for Course 108*a*.

110. *Advanced Systematic Botany.* — In the field the student will have practice in the identification and recognition of plants belonging to the more difficult groups, including grasses, sedges, pondweeds, and others, and in the identification of plants from fruit or leaf characters only. The characteristics of these families will be presented both in the field and by lecture. The lectures will also consider the evolution and relationships of the angiosperms, the rules of botanical nomenclature, and the present trend of systematic botany.

Thursday. *Two hours credit.* Dr. EHLERS.

Prerequisite: Botany 104 at the Station or Botany 8 at the University, or equivalent preparation elsewhere.

This course gives full credit to graduate students.

112. *Special and Research Work in Botany.*—Students who have taken Course 104 or 106 or have had adequate botanical experience elsewhere, will find at the Biological Station excellent opportunities for further study or research in many lines of botany. Undergraduates, or graduates beginning research and consequently needing personal direction, are advised to choose a problem along ecological anatomical, or systematic lines. By special arrangement qualified students may carry on investigations on the fungi of the Douglas Lake region. It will be necessary, however, for the student proposing to work on the fungi to consult personally with Assistant Professor C. H. Kauffman in Ann Arbor before electing the course. Students from other institutions should write Professor Kauffman before making the trip to Ann Arbor. The work on the fungi at the station will be under the supervision of Dr. Ehlers. The results of each investigation carried on under direction are to be embodied in a report. Advanced students or independent investigators are free to choose problems in any line of botany, and every effort is made to provide them with the necessary facilities and equipment for their work.

Days to be arranged. *Two, four, six or eight hours credit.* Assistant Professor GATES and Dr. EHLERS.

Prerequisite: Admission only by arrangement with the instructors in charge.

This course gives full credit to graduate students.

THE UNIVERSITY BULLETIN IS REGULARLY ISSUED BY THE UNIVERSITY OF MICHIGAN ONCE EVERY WEEK.

ENTERED AS SECOND-CLASS MATTER AT THE POSTOFFICE AT ANN ARBOR, MICHIGAN.

THE BULLETIN INCLUDES THE FOLLOWING PUBLICATIONS:—

The Annual Report of the President.

The Catalogue of the University.

The Annual Announcements of the College of Literature, Science, and the Arts, the Colleges of Engineering and Architecture, the Medical School, the Law School, the College of Pharmacy, the Homœopathic Medical School, the College of Dental Surgery, the Graduate School, and the Summer Session.

Other Announcements of the several departments of instruction, Reports and Communications of University officers, etc.